IT Projects: Classifying Risk Factors and Identifying Project Outcomes

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***Abstract*—The necessity to discover risk factors that could lead to failure will continue as many IT projects continue to fail or stay in the area of Grey IT Project (GITPro). The current study is an exploratory examination to identify IT project risk factors across the private and public sectors in Saudi Arabia. Data were collected through semi-structured in-depth interviews using the critical incident technique (CIT) with 15 IT managers. Then, the data gathered were analyzed using an inductive thematic analysis method. The study finds 18 IT risk factors with actions undertaken to avoid every risk. Findings suggest that a new framework of Risk Factor Classification (RFC) and Project Outcome Model (POM) can play a significant role in risk management.**

***Index Terms*—failure, IT project, risk factors, success**

I. Introduction

Most recent studies have shown that the failure rate of IT projects is high. Only 16% of IT projects were successful in 1994 while in 2008 this rate increased to 32% [1]. According to CHAOS reports, over the past 16 years, the average of successful projects is only 29%, the average of failed projects is 24%, and approximately half of the number of projects (47%) are challenged projects [2]. Also, studies have shown that IT risks play a key role in decreasing successful information technology projects [3], [4]. Indeed, decision-making is risky in the IT sector [5].

IT projects have unique characteristics that are totally different to those of other types of project. Almost all research shows that IT projects are complex and costly [6], [7]. There are some further characteristics of IT projects: they are challenging; they require a high level of skill; and they may be high risk [8].

Many organizations have invested a huge amount of money in information technology in Saudi Arabia, which has one of the biggest IT markets in the Gulf region [9]. The IT market in Saudi Arabia had a value of US$3.3 billion in 2010, and is expected to increase to US$4.6 billion by 2014 [9]. The Communications and Information Technology Commission (2009) shows that estimated IT spending was SR 22.3 billion in 2009, as the largest market in the Middle East [10]. There will be a huge demand for software developers, systems analysts, IT project managers and IT consultants from 2010 to 2014 [10].

There are some recent reports that express the reality of information technology in Saudi Arabia. The King Abdulaziz City for Science and Technology, (KACST) and the Ministry of Economy and Planning (MEP), have issued a new report entitled, "Strategic Priorities for Information Technology Programs" [11]. According to this report, Saudi Arabia is the 49th largest producer of IT research publications, issuing 24 articles out of 22,220 during the period from 2005 to 2007.

This paper first gives a brief overview of project success and failure. Then, it describes the definition of uncertainty and risk. After that, it explains the research approach used in the data gathering and analysis. Next, it discusses the results. Finally, the study summarizes the findings and contributions.

II. Project Success and Failure

The literature review has presented many definitions and conceptions of success and failure. Project success is "equally as complex to define as failure" [12]. It is difficult to know how to measure project success, and the factors of success or failure differ in many studies [13]. Project success has two elements: project management success and project product success [14]. There is a difference between project management success and project success [15]. The overlap between project and project management occurs in: the time frame; the objectives of project success and project management success, which are often intertwined; and ease of measurement [16]. Whilst project management may be able to achieve project success, this does not mean, necessarily, that it can prevent project failure [15].

Many researchers have shown that time, cost and user specification are success criteria [17]-[19]. A successful project should meet time, cost and user requirements as well as gauge the impact on computer operations [20]. Project success can occur, even if it does not meet budget and time schedules [21]. However, a project can be

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considered as having failed, even if the technical system has achieved its goals [22]. Moreover, a project can be a success for one party and a failure for another [15].

The success or failure of an IT project are difficult to define or measure; the concepts are debatable. In fact, information system success is a fuzzy concept that depends on different types of information technology and different stakeholders [23].

Project success is the satisfaction of all stakeholders [24]. Therefore, project managers have to obtain agreement from all stakeholders on the success criteria [25]. However, it seems unlikely that the project could be a full success for all stakeholders throughout the life of the project [15].

Finally, it is difficult to define the success or failure of a project because, as Wateridge confirms, success and failure are not 'black and white' [21]. Thus, researchers have tried to create or find success factors to lead projects to success.

III. Uncertainty vs Risk

Uncertainty can occur at any time during the project in plan, process or people. Whitty and Maylor describe uncertainty as "a fundamental characteristic of all projects" (p. 306) [26]. Several researchers define uncertainty as the absence of information [27], [28]. Galbraith argues that uncertainty is the gap between available current information and the information needed to make a decision [29]. In fact, uncertainty is an unknown incident which could be negative or positive in the context of the project. According to Wideman, uncertainty can be risks or opportunities in the context of project management [30].

Risk is defined as uncertainty about results or events, particularly with regard to the future [31], [32]. Miles and Wilson argue that risk is a barrier to success [33]. PMBOK defines risk as "an uncertain event or condition that, if it occurs, has an effect on at least one project objective" (p. 275) [34].

According to Stevenson and Jarillo, opportunity is defined as a "future situation which is deemed desirable and feasible" (p. 23) [35].

IV. Research Approach

The critical incident technique (CIT) was used in this study. It was developed by John Flanagan (1954) during World War II to identify combat leadership and pilot disorientation [36]. Although CIT was originally used to address issues in pilot performance, the technique has been employed in various fields of social science such as counseling [36], engineering [37], management [38] and computing [39].

Flanagan describes the critical incident technique (CIT) as: "A set of procedures for collecting direct observations of human behavior in such a way as to facilitate their potential usefulness in solving practical problems and developing broad psychological principles" (p. 327) [40].

With the critical incident technique, it is useful to collect significant biographical data about the participants, which are only used descriptively in this study. Semi-structured in-depth interviews were used for CIT. According to Woolsey, the size of a sample is not determined by the number of participants but by the number of incidents until saturation appears [36]. However, 12 interviews should be enough for conducting quality research [41].

Because of the limitations of time and cost, two sample approaches were used to conduct semi-structured interviews: (i) purposive sampling and (ii) snowball sampling. Although these sample approaches can generate various and inaccurate data, a strict guideline of looking for IT project managers was used with no less than five years of experience in the IT industry, with at least three IT projects. As another guideline, participants must all be a member of at least one of the popular organizations such as Project Management Institute (PMI). In fact, three expert participants were identified through "purposive sampling" who met the guidelines, and then they were asked to suggest more experts through "snowball sampling" who also met the guidelines. Thus, the sample size of CIT was 15 IT project managers who were interviewed in Saudi Arabia, discussing about 30 projects.

Three IT managers, who didn't meet the above guidelines, participated in a pilot study to test the questions, and, as a result, no important changes were made to the interview questions. However, this pilot study was not included in the analysis of the data.

All interviews were analysed using an inductive thematic analysis method. The reason for this choice was that thematic analysis is appropriate to identify the themes. The process of this method followed the six phases of analysis described by Braun and Clarke [42]:

- Becoming familiar with the data
- Generating initial codes
- Searching for themes
- Reviewing themes
- Defining and naming themes
- Producing the report

V. Findings and Discussions

A. Profile of Respondents

The goal of this part is to present a brief narrative of the characteristics of the IT managers participating in the CIT in Saudi Arabia. This part of the interview includes the following criteria:

TABLE I. The Nationality of IT Managers

Nationality	Number	%
Saudi	6	40
Non-Saudi	9	60

Table I shows that 40% of the IT managers of the CIT sample were Saudi while 60% were non-Saudi, and all of them were male. This leads to two assumptions. The first is that the IT industry in Saudi Arabia still depends on foreign expatriates.

According to Saudi Arabian Monetary Agency, 89.6% of the private sector labour force was non-Saudi while 10.4% was Saudi [43]. In general, the IT industry is managed by the private sector. Second, the IT gender gap remains an issue, not only in Saudi Arabia but globally.

TABLE II. THE AGE OF IT MANAGERS

Age	Number	%
> 30	3	20
30-40	4	26.7
40-50	6	40
<50	2	13.3

Table II displays the distribution of age in the sample. As shown, 40% of the IT managers were in their forties.

TABLE III. THE EDUCATION LEVEL OF IT MANAGERS

Education Level	Number	%
Bachelor	11	73.3
Higher than Bachelor	4	26.7

In terms of educational background, 11 IT managers of the CIT sample had completed a bachelor's degree, while only four had also completed a degree higher than a bachelor's as seen in Table III.

TABLE IV. THE FIELD OF ORIGINAL OF IT MANAGERS

Field of Original Study	Number	%
Engineering	3	20
Business	3	20
IT & Computing	7	46.7
Other	2	13.3

Table IV summaries the field of original study of IT managers. It is clear that more than half of the sample did not qualify in IT. However, Engineering and Business schools have majors and courses that are related to IT science.

TABLE V. NUMBER OF YEARS AS IT MANAGER

Number of years	Number	%
>5	0	0
Between 5 and 10	9	60
Between 11 and 15	4	26.7
<15	2	13.3

Table V shows the number of years as IT project manager. Interviews were conducted with those who had spent less than five years as an IT manager. Regarding this study, 60% of the sample had between five and ten years as an IT manager.

TABLE VI. NUMBER of IT PROJECT

Number of IT project	Number	%
>3	0	0
Between 3 and 6	2	13.3
Between 7 and 10	6	40
<10	7	46.7

Table VI displays the number of projects that IT managers participated in. Interviews were not conducted with those who had participated in fewer than three IT projects. According to this study, 46.7% of IT managers had participated in more than ten projects.

In terms of membership background, the majority of this sample (10 out of 15) were PMI members. Indeed, this organisation plays more of a key role in introducing the knowledge of project management than any other organisation, especially in the Arabian Gulf.

B. The Realistic View of IT Project Failure

Before determining the causes of IT project failure, the study should provide a sensible and practical definition for this kind of failure. The first interview question for the participants was:

"*What is IT project failure?*"

It is important that the main goal of this question functioned as a preamble, for finding the reasons for IT project failure and also for setting up the logical sequence of the search process. The interviewees were asked simply and directly to define IT project failure. In fact, the invisible aim of the question was to look ahead to understanding and highlighting project management activities for IT projects based on the definitions given by the respondents.

Although the above question was simple and straight forward, the responses varied depending on a number of personal factors including education level and experience.

The following responses show the loose definition of the word failure,

"It is really a hard question, but what I believe is that the meaning of failure to me is not like the meaning of failure to you" [ITPM 03]1.

"I think we should define failure before defining IT project failure. From my experience, failure and success are debatable words but failure usually paves the way to success" [ITPM 08].

"I suppose failure is not always bad. It is helpful when you are looking to the future, not to the past" [ITPM 12].

Nevertheless, inspecting some other answers given by the IT managers can give a general framework for a definition of IT project failure. The following responses discuss the project management activities:

"I think IT project failure is a result of unprofessional management practices employed by the project team. In reality, addressing unprofessional management practices is important in putting IT projects on the right way" [ITPM 05].

"It is a difficult question....IT project failure is a situation of not meeting planned goals set by the stakeholders. I would confirm that meeting a planned goal is an incentive factor that leads any project to success" [ITPM 08].

"...It [IT project failure] is a risk followed by other risks, and continues without immediate treatment from a responsible party...and there is no IT project without risk" [ITPM 02].

[1] IT Project Manager Interviewee number (03)

"This question is not easy. In my opinion, IT project failure means loss of control over the activities of the process of project management from a project manager" [ITPM 14].

"IT project failure means that the project expectations are not satisfied by stakeholders...and satisfaction is a critical line between failure and success" [ITPM 01].

"I think it is a tricky question, however, IT project failure is an outcome of bad time management within the whole project by the team" [ITPM 09].

According to the previous responses, it is clear that the participants describe the term "IT project failure" by referring to some poor project management activities. Thus, it could be said that a failed IT project is a result (product or service) of unprofessional management practices (related to plan and process) employed by the project team (people). Process, plan, people and product are combined elements for any project, and they can play a key role in giving a realistic view of IT project failure or success.

The analysis of responses to poor activities of project management for IT project failure may be linked to the following elements in project management knowledge: process, plan, people and product (3Ps = P) as seen in Fig. 1.

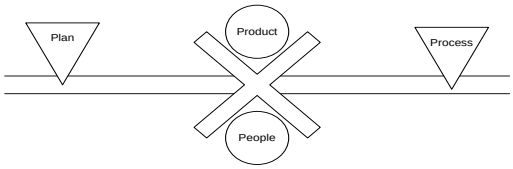

Figure 1. 3Ps = P

Thus, IT projects can be defined as end products or end services that managed by people, by making a balance between plan and process. The next conceptual equation and figure show the relationship between these elements of 3Ps = P as seen in Fig. 2.

*IT project = [(Plan * Process) / People] = Product*

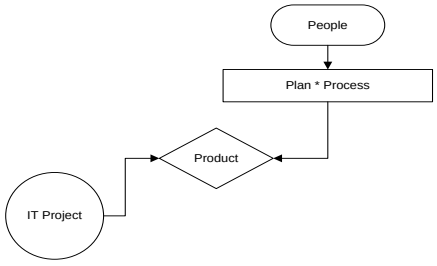

Figure 2. The relationship between elements of 3Ps = P

C. Risk factors of IT Project Failure

In the context of 3Ps = P, there are two suggested circles: the circle of uncertainty and the circle of certainty (see Fig. 3).

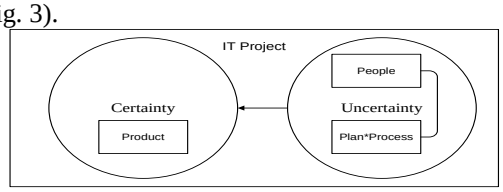

Figure 3. The circles of 3Ps = P

In this paper, uncertainty can be classified as out-of-control risk and under-control risk. Thus, a risk can be a threat if it is out of control, and can be an opportunity if it is under control.

The following response highlights how a threat can convert to an opportunity in an IT project,

"...one time I discovered that one of my project team was an unskilled developer. So, I had to take a step to solve this issue. I had only two options: getting him training or replacing him with a skilled developer. The decision was the second option" [ITPM 08].

In designing the CIT interview, one important prepared question for the participants was:

"Think of the last two IT projects in which you have recently been involved. What are the risk factors that could lead to IT project failure?"

Once the participants had discussed a particular risk factor and wanted to mention another, the participants were asked the following question:

So what did you do to avoid this risk factor?

The IT managers were asked to discover the risk factors which can lead a project to fail. Risk factors were identified based on the last two projects in which the participants had recently been involved. Based on the interview responses, we organized similarly coded data by theme, three of which have been identified within the data: (i) managerial risk factors; (ii) technical risk factors; and (iii) financial risk factors.

Table VII highlights the risk factors and actions undertaken to avoid every risk factor identified by the participants in Saudi Arabia.

TABLE VII. RISK FACTORS AND ACTIONS UNDERTAKEN

Risk	Actions Undertaken
Managerial	
Poor communication	Develop communication method
Failure to identify all stakeholders	Review the list and try to identify the rest of stakeholders
Misunderstanding user requirements	Review user requirements documents to meet needs
Lack of planning	Create work breakdown structure (WBS)
Unrealistic time schedules	Use critical path and critical chain methods
Unrealistic cost estimates	Use parametric cost estimating
Unclear objectives	Review project charter to ensure objectives have been defined well
Lack of user participation	Send a letter to department manager and CC to top management
Conflict between users	Identify conflict causes
Lack of top management support	Meet with the general manager to obtain support
IT staff turnover	Develop motivation and reward system
Inexperienced IT staff	Conduct training sessions or Replace staff member
Resistance to change	Inform staff earlier about the aims of change
Technical	
Using inappropriate testing tools	Re-test by quality team
Using new technology	Outsource IT implementation
Poor quality code	Conduct training courses for programmers
Financial	
Lack of resources	Re-estimate and apply project resources
Size of project	Create contingency plans

D. Risk Classification Framework

One interesting aspect of the CIT study is creating a new framework of risk factor classification (RFC) based on the context of 3Ps = P. Therefore, this framework is a comprehensive risk classification based on two axes of an IT project manager's view: (i) the level of risk and (ii) the level of control. The framework divides risk factors into four classifications: plan, process, people and product (see Fig. 4).

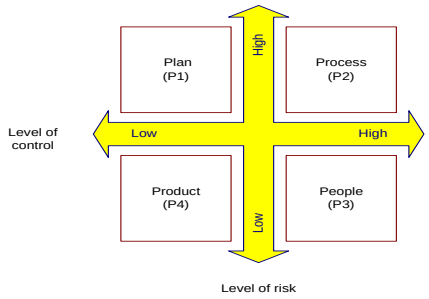

Figure 4. Framework of risk factor classification (RFC)

According to the RFC framework, plan (P1) pays attention to risk factors that mostly happen in the early stages of a project's life cycle – particularly in the planning stage – such as unclear objectives. Process (P2) focuses on risk factors that mainly happen in the middle of project life cycle – especially in the execution stage – such as poor communication. People (P3) pays attention to risk factors relating to the persons involved in a project, such as conflict. Product (P4) focuses on risk factors that mostly occur after delivering a project.

Here, it is important to distinguish between risk factors relating to people that happen during project execution and others that happen in the daily operations of organisations. Indeed, a project manager has the overall liability and authority for the success of projects.

The level of risk for (P1) is high because a project manager is not the only key player in developing, for example, the project charter, or identifying objectives; there are other stakeholders with a share in it. Thus, a project manager has fairly low level of control over risk factors that fall in this area.

In (P2) the level of risk is also high because those risk factors occur throughout the stage of project implementation. Project managers have full responsibility of controlling and monitoring all activities during project execution so the level of control is high.

For (P3) the rank of risk factors relating to people is not high, because a project manager has a high level of control over any issue that might arise. It is important to know that implementing a project needs to assign a proficient team to ensure good results so every project manager is looking for skilled team. For example, an inexperienced IT member is a risk, but a project manager has options in order to take control.

For (P4) the level of risk and the level of control are low because an IT project or product is delivered. It means work is done and acceptable so project managers do not have the whole responsibility to follow after this point.

E. IT Project Considered Successful

After determining the risk factors of IT project failure, the study ought to present an understandable definition of IT project success. The last interview question of CIT was:

"When is an IT project considered successful?"

The purpose of the above question is to identify the criteria of IT project success.

All 15 IT managers mentioned 'time' as the first element of project success, showing that an IT project is considered successful when it is completed on time. It is not easy to submit IT project deliverables on time. The following response highlights why it is difficult to complete IT projects on time,

"...the biggest challenge for project manager is how to deliver the project on time" [ITPM 07].

Budget (or cost) was mentioned by every participant as the second element of IT project success criteria. When an IT project completed within budget, it is considered successful. It is apparent from few responses that there is a relationship between time and budget in the context of IT projects. The following responses show how a project delay can affect the project's budget:

"...the web development solution was carried out after the deadline by seven months, as the result of this delay; the project was over budget by approximately SR3,000,000" [ITPM 10].

"...actually as the project manager, I cannot estimate costs after project deadline especially if I do not have contingency plans" [ITPM 13].

The requirement to meet needs is mentioned by the respondents in different ways. Some show that an IT project is considered successful when stakeholder expectations are met, whereas some think that meeting user requirements is an important criterion to success. Others suppose that meeting a project's scope or objectives is significant factor of project success criteria. The following response shows that one project goal is meeting stakeholder needs:

"...when a project starts up, my team and I seek to obtain the main goal of project to achieve stakeholder needs in framework of setting cost and time limits" [ITPM 02].

In terms of work, the majority of interviewees thought that IT projects should work to be considered as successful. Ten out of fifteen of the participants claimed that IT projects have to be used by end users or customers.

Once an IT project has met the needs of the stakeholder, it will most likely to be accepted by users or customers. In fact, time and budget are the main factors in setting the boundaries for projects; but, meeting needs is the most important purpose of an IT project.

Overall, there was a sense of interviewees felt that the above criteria in general may help to detect when IT projects are expected to be successful. From this point of view, we suggest a new way tool to identify all the potential outcomes of project. This tool is named The Project Outcome Model (POM) (see Fig. 5) which uses all the above criteria of IT project success. However, we employ the term of stakeholders' expectation instead of

work and used because it is comprehensive. The previous model consists of the following elements:

- Four hypotenuses which represent meeting the needs of the project
- Line of time
- Line of cost
- Four uppercase letters (small square) which represent the outcomes of the project
- Four corners (big square) which represent stakeholders' expectations.

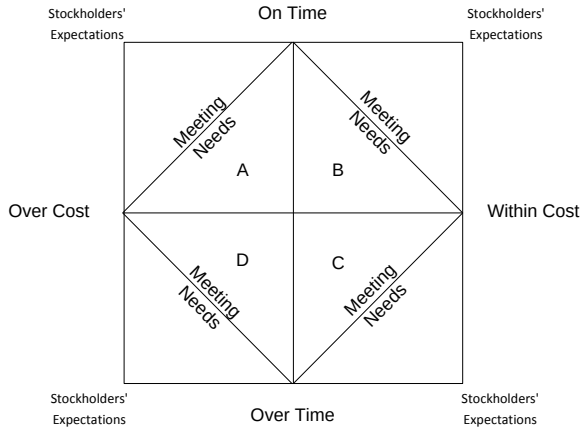

Figure 5. Project outcome model

Square A is a grey outcome for a project that is considered challenged (completed on time, over budget, and meeting needs). In square A, the hypotenuse represents the minimum acceptable meeting of the needs of the project. This result could be examined by MITPOT to convert it to be successful as square B or failed as square D.

Square B is an optimal result for any project that is considered successful (completed on time, within budget, and meeting all needs). In square B, the hypotenuse represents the maximum acceptable meeting of the needs of the project. However, the area of the square – between the hypotenuse and corner of expectations – is known as gold plating. This means in project management any additional feature or attribute not considered in a project [44].

Square C is a grey result for a project that is considered challenged (completed over time, within budget, and meeting needs). In square C, the hypotenuse represents the minimum acceptable meeting of the needs of the project. This result could be tested by MITPOT to change it to be successful as square B or failed as square D.

Square D is an unpleasant outcome for any project that is considered failed (completed over time, over budget, and not meeting all needs). In square D, the hypotenuse represents the maximum unacceptable meeting of the needs of the project.

The Project Outcome Model (POM) is created to be a suggested tool for a project management office (PMO) to determine the area of Grey IT Project (GITPro) that should be examined by the Model of IT Project Outcomes Testing (MITPOT) [45].

VI Conclusion

The main purpose of the CIT was to obtain a realistic definition of IT project failure and to identify risk factors during the execution of a project. IT projects are products managed by people, by making a balance between plan and process. The relationship between elements of 3Ps = P can be represented by the following conceptual equation:

*IT project = [(Plan * Process) / People] = Product*

The circle of uncertainty has two types of risks: out-of-control risks (threats) and under-control risks (opportunities), and both should be fall under the first part of the above equation (plan, process and people). Once an IT project is completed, the circle of certainty appears in the second part of equation (product).

This study identified 13 risk factors in the managerial theme. The technical theme showed three risk factors, while the financial theme had only two. According to the RFC framework, very high risk factors can fall in (P2) then (P1). The POM is developed to distinguish the outcomes of IT project. The main contribution of this study is the development of a framework of RFC and POM. As the future work, we shall further improve the RFC and POM and validate them in a larger sample size.

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